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WILDLIFE CONSERVATION

'S PAST -- ITS PRESENT -- ITS FUTURE

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WILDLIFE CONSERVATION

Its Past • Its Present • Its Future

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I. The Land We Inherited from the Indians

THE first white men who set foot upon the soil of what is today the Commonwealth of Pennsylvania found a land of seemingly inexhaustible fertility. They found great expanses of forest literally teeming with an amazing variety of wild creatures. Nowhere else had these men, or any other white men, witnessed such a luxuriance of woods, of waters, and of wildlife as they had found here on this new continent of North America. This land, later to be christened "Penn's Woods," or Pennsylvania, was as beautiful and as bountiful a land as ever existed on the face of the earth.

For ages untold, Nature had been preparing the land and had clothed the mountain ranges, the rolling hills, and the broad valleys with vast forests of noble trees. It had, indeed, taken many centuries for these forest giants to grow and for these forests to develop. The litter which had accumulated on the forest floor—the soft, spongy mass of decaying and decayed organic material—absorbed most of the rainfall and slowly fed this water into many thousands of springs and these, in turn, fed the numerous streams. These forests thus served to regulate the flow of water from the land. Although there were occasional periods of high water when the rainfall was abnormally heavy, the forests did much to regulate the run-off and floods were not a serious matter. Even when excessive run-off did occur, the waters did not become muddy because the forest cover largely prevented the soil particles from being washed away from the land into the streams.

Today we may wonder what the original or virgin forests were like. We know that these forests were as variable as they were extensive. Trees native of the North and of the South here joined hands. A vast area in the north-central part of the state was covered with a dense forest growth in which the white pines and hemlocks predominated. The huge trees, many of them five feet in diameter near the ground, often grew so close together that their lofty crowns practically cut off the sunlight from the ground beneath. It was like twilight at midday in this forest; the once famous "Black Forest" of Pennsylvania. In the eastern and western portions of the state, and in the mountain valleys extending up from the South, there were equally extensive forests of hardwoods such as the oaks, hickories, ashes, maples, and numerous other broad-leaved trees. The mountain ridges of the south-central portion contained forests of giant chestnut trees, rock oaks, and pitch pines. Lesser areas in the glaciated Northwest and Northeast were occupied by Northern bog-type forests of tamarack, spruces, balsam fir, and paper birch.

"This land . . . was as beautiful and bountiful a land as ever existed on the face of the earth."

With the exception of small natural openings, scattered bits of meadow land, steep cliffs, and water areas, the entire state was covered with tree growth. Possessed with such a variable forest habitat, the stage was all set for its inhabitance by a great variety of birds and mammals. Judging from all of the earlier accounts they were present in almost unbelievable abundance. In most of the forest area deer, bear, and bison were plentiful; and elk herds roamed the northern ranges. The predatory wolves, cougars, and wild cats were common, too. Beavers built their dams and lodges along many of the streams; and otters made their homes in many of the lakes, and ponds, and creeks. The fisher and the agile pine marten dwelt in the shadowy recesses of the evergreen forests. Wild turkeys and grouse frequented the more sunny openings where seeds and berries were abundant. Immense flocks of waterfowl composed of many species of ducks and geese, thronged the waterways, lakes, and marshes on their spring and fall migrations. A brilliantly colored little parrot, the Carolina paroquet, on occasions frequented the forests. Truly this land was a wildlife paradise, but perhaps nothing ever witnessed by man surpassed the spectacular flights of the native wild pigeons as they roamed the vast reaches of this primeval wilderness.

The passenger pigeon once existed in unbelievable numbers; literally millions of them must have comprised the immense flocks which wandered the woodlands, following the crops of mast, seeds, and berries. For hour after hour the birds would darken the sky as a great living cloud.

The original human inhabitants of the land, the Indians, were as much a part of it as were its furred and feathered denizens. The forest and its wildlife provided most of their needs as to food, clothing, and shelter. Wild fruits, nuts, and edible seeds and berries could be obtained almost anywhere. The elk, deer, bison, bear, and a host of smaller mammals provided an ample source of flesh, furs and skins. Then, too, there were wild turkeys, grouse, pigeons, and waterfowl in great abundance. The many thousands of miles of streams and the glacial lakes abounded with fish, frogs, turtles, and mussels. Scattered through the forests, and located usually along the banks of streams, were a number of Indian towns or villages with houses constructed of logs, bark, and hides. In small clearings these people practiced a primitive sort of agriculture and raised crops of maize, squashes, and beans. Many of the picturesque names of places, of rivers, lakes, and mountains in Pennsylvania are of Indian origin. It is evident that the Indian, even though he obtained the greater portion of his living from the forest, was not a destructive factor. The native population was never large, and their weapons and implements were far less efficient than those later employed by the white men. The Indian seldom, if ever, took more wildlife than he had actual need for. Their wilderness paradise remained intact, through centuries of use and occupation, until the coming of the white man and his civilization.

II. The Era of Exploitation

Nearly all of the accounts sent back by explorers and settlers made at least some mention of the bountifulness of Nature in this New World wilderness. To many the forests seemed as vast and endless as the waters of the great ocean they had crossed. There certainly seemed to be no end to this sea of trees which extended across the mountain ranges and flowed over the rolling hills and down the valleys. Here, indeed, men thought they had found an inexhaustible supply of timber to meet all of their needs and for all time to come. The abundance of wildlife, particularly the numbers of game birds and mammals, the prolific fisheries, and the wealth of fur-bearers, soon became common knowledge. Men had never seen anything like it anywhere in the world before.

"There were wild turkeys . . . in great abundance."

Like the Indians, the pioneers obtained a large part of the necessities of life from the surrounding forests; but unlike the Indians these white men were not satisfied only with the supplying of these necessities; and they soon sought to convert the natural resources of the land into cash. Not infrequently the forests were considered to be an obstacle in the very path of their expanding civilization; and the trees were girdled, felled, and often burned simply to clear the land. Timber was so abundant and so easily obtainable that men not only used but destroyed it with reckless abandon. Fires were allowed to sweep through the forests, and they came to be looked upon as a customary aftermath of the sawmill. Ready markets were soon found for furs and hides, and to some extent for the flesh of the larger mammals. Eventually the market hunters found a good trade in all species of game while others did a flourishing business in the plumage of wild birds. Sometimes, just for sport, men would stage what were called "wild animal drives"; and wholesale slaughter of wildlife, both of game and of predators, would result.

In the course of time the white man's civilization spread throughout the former wilderness, and the great forests of Penn's Woods were gradually consumed by the saw mills. Farms and thriving communities took the place of much of the land once covered with trees. In a little more than two centuries the "inexhaustible forests" had very largely come to their end, and men began to face the necessity of looking to more and more distant forest lands to provide a timber supply. From the beginning the lumbering policy had been to cut and get

"Erosion was robbing even the more fertile farmlands of the life-giving top soil."

out, leaving behind a desolate, devastated land. Many of the once thriving communities of the lumbering days became mere "ghost towns", and soon little remained to mark their location save crumbling foundations and huge piles of sawdust. No effort was made to sustain the yield of the forests or to provide for future timber crops. Fires which swept periodically over the deforested land prevented natural reforestation; and subsequent erosion removed the fertile top soil, often gashing the hills with ugly gullies. Floods became more and more frequent and more and more devastating in the populated river valleys. Men began to wail and to curse Nature for their misfortunes, but few indeed realized that man and not Nature had been at fault.

Wildlife, of course, suffered the same plight as did the forests. The herds of bison, or buffaloes, were soon exterminated and were rapidly followed by the elk, beaver, marten, panther, and wolf. The black bear and even the deer were becoming exceedingly scarce over most of their former range. No longer did the beautiful Carolina paroquet add its touch of life and color to the woodlands. The great flocks of waterfowl ceased to come and go with the seasons, and each year saw their numbers constantly dwindling. Shortly before the close of the past century the last of the great flights of passenger pigeons put in their appearance, and only a few decades later the sole survivor of their legions died in a zoological garden.

The dawn of the present century found practically all of the virgin forests gone from Pennsylvania. A great deal of the land area, particularly in the mountains, was of little or no value for agriculture. Many of the poorly-paying mountain farms had been abandoned or were rapidly being abandoned by their discouraged owners. This land was suitable only for growing a new crop of trees; new forests to take the place of the vanished forests of other days. Much of it was lying idle; thousands of acres of fireswept, eroding land which was an increasing liability instead of an asset. Floods swept down the valleys depositing silt and destruction with them. Droughts became intensified because stream flow was not regulated. Erosion was robbing even the more fertile farmlands of the life-giving top soil. Thousands of miles of streams had become putrid highways of filth, untenantable by any useful form of life and a stark menace to the public welfare. Wildlife, particularly those species classed as game, was at a low ebb and disappearing fast. Now we had arrived at the conservation crossroads. It became a question of whether or not we were going to completely lose this great natural heritage of ours, the last remnants of which were rapidly slipping through our fingers.

III. The Era of Conservation

In these days we hear a great deal about the conservation of our natural resources. Conservation has been defined as the "wise use" of such resources. Now all of our natural resources are not necessarily to be conserved in the same maner. Some natural resources, once they are used up, can never be replaced. These are the *non-renewable* resources. They are an integral part of the earth, have always been there, or have been developed over such an exceedingly long period of time that we consider them as belonging to the earth's crust. In this class we have all of the mineral deposits such as the ores of iron, copper, tin, zinc, etc., and also the deposits of coal and oil. There is no method by which the supply of such resources can be replenished once they are gone although man may devise substitutes for some or all of them in the event this happens. The second group of natural resources are those which are capable of renewing themselves, the *renewable* natural resources, although some of them may require considerable time to develop. In this latter class we have such things as forests, grasslands, soils, and wildlife.

Plants and animals are living things, or as we often say they are "organic". In contrast to the non-living, mineral, or "inorganic" matter, living things have the power to *grow* and to *reproduce* themselves. Soils, in a certain sense, are in part built up by living things; and they contain a great deal of organic matter; but if all of the soil were to be removed, down to bed rock, it would require ages for its renewal. When we hear the word "conservation", it is usually in connection with these renewable natural resources; and it is in that sense that we are employing it here. As far as living things are concerned, there is always some hope of perpetuating them for the future. The era of conservation came too late to save the passenger pigeon, the Carolina paroquet, the great auk, and the heath hen from extinction. Several other species are even now on the borderline; but

we can be thankful that many, many more forms of wildlife did not pass down the faded trail and become but a memory.

It was fortunate that at least a few men foresaw the disastrous course we had been taking and that they possessed the courage and the ability to turn us from that course. That was not by any means an easy task, but we can be thankful that it was accomplished. The story of the long, uphill fight against the prevailing forces of power and greed is a most heartening bit of our national history—and it still continues. We in Pennsylvania can well be proud of the men who so ably, and unselfishly pioneered in the conservation movement as well as rejoiced in their accomplishments.

The first outstanding efforts were those directed toward forest conservation and the reforestation of the cut-over lands. These efforts very early resulted in a program of state acquisition of lands for forestry purposes. For the most part they consisted of these deforested "deserts" full of burnt snags and stumps; but, at the same time, a program of practical forest management was adopted; an efficient system of fire protection was set up; and nurseries were established to grow seedlings for replanting. It was proven that the forests could be brought back. Today few persons would dispute the value of the State Forests as a practical investment. They are not only growing a new crop of trees but providing recreation for thousands and protecting numerous important watersheds. In subsequent years the Federal government established the Allegheny National Forest at the headwaters of the Allegheny River in Northwestern Pennsylvania. Trees are a crop and will be handled as such on the State and National Forests.

Following closely in the steps of the forest conservationists, some of our sportsmen and naturalists laid the foundation of a program for game and general wildlife restoration. Stricter laws were formulated to protect song birds, game birds, and game and fur-bearing mammals. Areas were set aside, at first principally on the State Forests, as State Game Refuges. These were, in effect inviolate sanctuaries for wildlife. Today, in addition to the State Forests, more than 876,000 acres of land are being primarily developed for wildlife and public hunting under the title of State Game Lands. Through the untiring efforts of the Pennsylvania Game Commission and the sportsmen of the state, our wildlife situation has steadily improved; and again Penn's Woods has become an outstanding hunter's paradise. Efforts have been made time and again to alleviate the pollution of many miles of our streams, but thus far only with mediocre success. Much of the stream pollution is not at all necessary. The elimination of the pollution evil remains a challenge to all, not alone to the sportsmen who have thus far borne the brunt of the battle.

It cannot be denied that we have made remarkable progress in conserving our forests and our wildlife, but by no means have we solved all of our problems. We have only recently started to apply the scientific method of solving many of them. If conservation of forests and wildlife is to achieve the maximum possible success, we must seek for, and make a practical application of, the underlying biological principles. The practical and efficient forester or wildlife manager must possess a broad scientific knowledge of plant and animal life of the soils which sustain that life.

Years ago we started out with individual "pet peeves" such as forest conservation, game conservation, song bird conservation, etc.; but today we see all of these only as smaller aspects of the whole conservation problem. There was a day when a man could dump a dozen rabbits or pheasants in any field, put a few cans of bass fingerlings in his favorite stream, or plant an acre or two of pine trees and call himself a conservationist. Some men felt that if they went out on a "vermin hunt" and killed all of the hawks and owls they saw, they were practicing conservation. Right or wrong, no doubt all of these folks were sincere in their motives; but today we want to be sure if we are doing the proper thing and doing it in the right way. There is still much that we can learn about our conservation problems, perhaps we haven't even scratched the surface yet, but it does seem that we are on the right track.

The native vegetation which originally covered the land served to protect the soil from rapid erosion. In Pennsylvania this consisted largely of forest trees, but over large areas of the North American continent rank growths of grasses served as a binder for the soil and prevented it from being carried away by water or by the wind. It is, of course, quite natural for all of the higher land masses to erode, but this natural erosion usually takes place very, very slowly. Geologists tell us that the natural tendency is for the land to be worn down to a nearly level plain, even to sea level. In the earth's past history great mountain masses have been worn away by the action of the elements, but this is accomplished only over a very long period of many millions of years. It is much too slow a process to be at all evidenced in a normal lifetime of man. Very rapid erosion results, however, when the protective cover of vegetation is removed; and this rapid erosion has destroyed much good land in a comparatively few years.

Soil is derived from the underlying layers of rock as a result of the weathering, or the decomposition, of the rock material. Soils may be moved long distances from the parent rock material through such agencies as water, wind, and glaciers. If the soil particles are large, it is called *sand;* and if they are very, very small, it is known as *clay*. Most soils consist of a mixture of both and are known as *loam*. A *sandy loam* is a soil which has more sand than clay, and a *clay loam* one which has more clay in it than sand. The roots of plants penetrate the soil layer and help to bind the soil particles and thus keep them from being washed or blown away. When the living plants and animals die, their remains get into the soil where they slowly decompose and form *humus*. You are all no doubt familiar with the dark-colored layer of decayed and decaying leaves, branches, and trunks which forms beneath the trees in the forest. This humus in the soil both enriches it and greatly increases its capacity to absorb and retain water. It is what enables the soil to soak up water much like it is soaked up by a sponge. The leafy canopy formed by the vegetation helps to protect the soil from hard rains; and, to a considerable extent, it retards drying out of the soil during those periods when there is little or no rainfall.

What happens to the soil when the vegetation is destroyed? No doubt you have stood on a bridge over a small stream, or along the stream bank, after a hard summer shower and watched the swirling, muddy waters roll by. What you have seen was soil, the valuable top soil, on its way from the land toward the ocean. Every year the rivers of America carry away hundreds of thousands of tons of soil and dump it out in the ocean where it is lost forever as far as man is concerned. Some of it is deposited along the way as silt. This silt often destroys valuable beds of aquatic vegetation and interferes with the reproduction of fish and other aquatic animals. It also creates quite a problem by filling in reservoirs and the pools behind dams along the streams. All of us have noticed the gullies which are cut by the water in unprotected soil and in cultivated fields. Gullies are the most obvious aspects of erosion. It is not so easy to detect the work of sheet erosion which constantly robs a thin film of soil from the land surface.

Streams in forested areas usually remain quite clear, even after the heaviest rains, because the forest cover prevents the soil from being washed away. The rain water which falls in the forest is absorbed much more quickly and more completely by the sponge-like, humus-laden soil. A great deal of the water slowly percolates down into the sub-soil, to the reservoir of ground water, and is slowly fed into the springs and streams. Forests, and other areas well covered with vegetation, regulate the run-off of water from the land, retarding it during wet periods and releasing it slowly over an extended period of time. The run-off of water from bare ground is very rapid, and with each heavy rain considerable soil is washed away. This results in frequent floods, higher flood crests, and damage from silting. It is also to be noted that bare ground absorbs and stores very little water by comparison; and during extended periods of dry weather the springs and streams may completely cease to flow, thus intensifying the ill effects of drought.

Thousands upon thousands of acres of good, fertile farm land have been more or less completely ruined by the ravages of erosion. It has been going on for generations, but only within comparatively recent years have we awakened to fact and realized that its continuation amounts to economic ruin. *Soil conservation* is a new science in American agriculture, and we are hearing a great deal about it today. Our farmers are being shown how to save their soil; how to prevent its being stolen by wind and by water. In many cases this must mean a radical change in age-old agricultural practices. It means that lands too steep, or too poor, for profitable farming should be put into some sort of soil-building permanent cover such as forest or pasture. It means the adoption of crop rotation, contour plowing, strip cropping, and other practices designed to save and to build up the soil. The basic principle behind it all is to retard the run-off of water, and thus lessen its power to carry away the soil, and to retain the water upon the land where it will be able to do the most good.

Wildlife will benefit immensely through the soil conservation program, principally because in order to save the soil we must restore the vegetation and that means the restoration of wildlife habitat. The two go hand in hand. Gullies are being controlled by the means of dams and the planting of permanent vegetation such as trees and

shrubs. In a great many cases it has been necessary to restore lakes, ponds, and marshes, which had been previously and unwisely drained, and to create new ones in order to retain the water and establish higher water tables for agricultural crops. Conservation is very largely a matter of conserving, or restoring, nature as a whole—forests, farms, fish, birds, and mammals. The very foundation of any real conservation program must essentially be built upon the conservation of the soil and water resources which are so essential to all life.

V. Water and the Water Cycle

Water is essential to all life. Even if we have good, fertile soil and water is lacking, it will not support living things. Plants attain their maximum abundance and the growth of vegetation is most luxuriant where there is an abundance of moisture in the soil. In desert regions the plant life is sparse, and such plants as do exist there have adapted themselves for life under conditions of extreme drought. Most of these plants have very small leaves, or no leaves at all; and their stems have been modified to serve as storage places for water. On the other hand we find very dense growths of vegetation in the warm and humid tropical lands where rainfall is abundant and well distributed throughout the year. Forest trees require a goodly amount of water while grasses and some other herbaceous plants can thrive on lesser amounts and are able to grow on lands which do not receive sufficient moisture to support trees. The great grasslands which occupied the Western plains were able to occupy that land simply because the rainfall was insufficient to permit tree growth. The type of vegetation found in any region is a result of the amount of rainfall and the capacity of the soil to retain moisture.

Water exists in three states: as a *liquid,* as a *solid* (ice), and as an invisible *gas* (water vapor). If we were to pour some water into a shallow pan, and leave it exposed to the air and sunshine, we should see that it gradually disappears. We cannot see where the water is

"Water is essential to all life." *Hal Harrison Photo*

going but by simple deduction we can tell that it is going into the surrounding air. The process by which the liquid water is turned into an invisible vapor and vanishes into the atmosphere is known as *evaporation*. The atmosphere is constantly obtaining water in a vapor form from the earth's surface—from the surfaces of the oceans, ponds, lakes, marshes, and all other water areas, from the soil, from the vegetation, and from many other sources. This water vapor is carried aloft by air currents; and when the air becomes cooled at high altitudes, this water vapor *condenses* to form clouds; and ultimately it falls earthwaard again as *precipitation* such as rain, sleet, or snow.

When rain falls upon the surface of the earth, it tends to flow from the land toward the great storage basins we know as the oceans. Some of it is evaporated again in falling toward the earth, or evaporates soon after it reaches the earth's surface, but most of it either runs off the land into the creeks and rivers or is absorbed by the soil. The surface run-off is regulated to a remarkable extent by the vegetation. Some of this water retained by the soil is used up by the vegetation; but a great deal finds its way downward into the subsoil and the porous rocks beneath. Water may be stored in the ground for considerable periods of time, but eventually it escapes through springs and seepage areas. Water is also stored in natural basins, or depressions, on the surface of the earth such as lakes, ponds, swamps, or marshes.

To obtain the greatest good from the water which falls upon the earth's surface it is necessary to retain it as long as possible upon the land. Man, however, learned the truth of this matter the hard way. For years he labored to hurry the water off the land in the shortest possible time and by the most direct route. He constructed ditches and drains and often straightened out the stream channels to expedite its movement. During the past century Americans went on a drainage "spree", and now we have begun to witness the results. The wholesale drainage of lakes and marshes has brought about a general lowering of the ground water level (the *water table*). This has had serious repercussions on agriculture in many localities. With the advent of the drought years, growing plants suffered because lowered water tables meant that practically no moisture was available. Much good farm land has been ruined by unwise drainage projects. We have also done much toward hastening the water off the land through the removal of forests, grasses, and other native vegetation; and we have experienced the results in rapid erosion of the soil, devastating and frequently occurring floods, and other consequences.

Wildlife, too, must have water; but through many ill-advised drainage schemes we have destroyed hundreds of thousands of acres of the best wildlife habitat. Waterfowl, in particular, have suffered tremendously by the destruction of great breeding grounds, both in this country and in Canada. Now some of the land which was obtained by draining off the water proved to be good farm land; but many, many thousands of acres of it proved otherwise. Valuable lakes and marshes were pawned for worthless alkali flats and dust bowls. Since man has learned that he was wrong, and that nature was right in the first place, he has been endeavoring to amend much of the damage which he has done. This, however, is going to cost millions in dollars

"Waterfowl have suffered tremendously by the destruction of great breeding grounds."

and require a great many years to accomplish: but, out of sheer necessity, it must be done. Soil conservation, flood control, and agriculture all require that water be retained upon the land as long as possible; retained for the use of growing crops, for livestock, for wildlife, and for man's own recreational use. Water must be retained in order to make it serve many useful purposes instead of becoming a monstrous agency of destruction sweeping toward the sea.

Pure water is a precious asset, but man has been respousible for the misuse of water areas just as he has been guilty of the misuse of our other natural resources. Many sources of drinking water have been rendered *unpotable*, or unfit for such use, through *contamination* by organisms which are apt to cause disease. Thousands of miles of streams have been *polluted* with industrial wastes and with raw sewage so that they no longer produce fish and other valuable aquatic life or serve any other useful purpose. This use of streams for the disposal of man's filth and poisons is certainly neither a wise nor a legitimate use. Much of the pollution is neither necessary nor excusable in the light of man's present knowledge and ability to take adequate care of wastes, and to render them innoxious before their discharge into any stream or body of water. Some of the industries which insist on dumping their wastes into streams, and plead that such practices are necessary, may often be of infinitely less value to a community than the unpolluted stream would be. Water is of vital importance to all living things, and without it life would be impossible. It is one of our most precious assets, or it can be one of our most heartless masters.

VI. The Importance of Plant Life

Without plants no animal life could exist upon the earth's surface. Green plants alone have the ability to make food out of inorganic matter. Animals of all kinds, including man, are dependent upon

plants for use of all their food. With all of man's knowledge of chemistry and his almost amazing creative ability he has never been able to make even a single ounce of food from the basic, inorganic elements. This secret is still locked up in the green leaf. We know a great deal about what takes place there, but apparently we don't know just exactly how it is done.

The green parts of plants are green because their cells contain a green pigment known as *chlorophyll*. This pigment is not scattered throughout the cells but is contained in little bodies in the cells which are known as *chloroplasts*. Now the green leaves, and the other green parts of plants, are in a way "food factories." These little chloroplasts constitute the machinery of the plant "food factory." We all are aware of the fact that energy of some sort is required in order to run a machine of any kind. Man has often used his own energy, the energy of other animals, of waterfalls, steam, electricity, or explosives to run his machinery. The source of the energy used in the plant "food factory" is one which man has scarcely yet been able to harness and use; it is energy of sunlight. We also know that any factory must have raw materials from which the finished product is made and that there are certain leftover waste products, or by-products, which result from the process of manufacturing. All of this is equally true of the plant "food factory." One of the raw materials used in the manufacture of food is a gas taken out of the air. This gas is called *carbon dioxide*, and each molecule of it consists of one atom of carbon united chemically with two atoms of oxygen. Carbon dioxide exists in the atmosphere in the proportions of three parts in every ten thousand. This gas is given off by all animals during the process of respiration, or breathing.

Another of the raw materials utilized is familiar to all of us; it is nothing more than water which is derived from the soil by the plants. Water is composed of two atoms of hydrogen chemically united with an atom of oxygen. In the plant "food factory" these two raw materials are broken down and reconstructed in the form of sugars and starches. These consist of various combinations of carbon, hydrogen, and oxygen atoms and are known as the *carbohydrates*. In the process of food making, which is called *photosynthesis* (to build up by means of light), the waste material is the gas oxygen which is essential to all animal life both on the land and in the waters. This important by-product is returned to the atmosphere, or absorbed by the water in the case of the aquatic plants, and thereby made available for use by animals.

Some kinds of plants do not possess the green chlorophyll, and therefore they are unable to make foods, but they do perform other useful biological functions. Fungi of all kinds, and the microscopic bacteria, are in this class of plants. Some, it is true, cause diseases of other plants and animals, including man; but many others perform distinctly valuable services. One of these essential biological functions is that of bringing about the decay of dead plants and animals and the return to the soil and to the atmosphere of their inorganic components. If this process were to cease, the whole surface of the earth would eventually become hopelessly littered with organic remains and reach a point where living things would find it impossible to exist any longer.

It is, therefore, of vast importance in the cycle of life. The mineral matter, which is returned to the soil when products of life decay, is used over and over again by other living things. That is why humus enriches the soil and keeps it in a state of productivity.

One of the elements which returns to the soil when organic matter decays is nitrogen. Now nitrogen is one of the principal constituents of the air, comprising as it does approximately four-fifths of the total volume of the atmosphere; but plants are not able to use this free, gaseous form of nitrogen. It is available for plant use only in the form of nitrates present in the soil and capable of being dissolved by the water in the soil. Certain bacteria which are found in the soil and in the root nodules of plants of the pea family, have the ability to convert this free nitrogen into the usable nitrates, thus making it available for general use by plants. When nitrogen is added to the carbon, hydrogen, and oxygen in the plant "food factory," another important food is the result. This is *protein*. Plants also use small amounts of various soil minerals such as iron, calcium, potassium, magnesium, phosphorus, and sulphur; and animals obtain most of these essential minerals from the plant foods which they eat.

We have already stated that no animal has the ability to make food. The only exceptions are certain single-celled flagellates which contain chlorophyll; and these forms are on the borderline between the plant and animal kingdoms. Animals, therefore, are dependent upon the plant world for all of the food which they eat. Some animals, it is true, derive all or the greater portion of their food by devouring other animals. Indirectly even these flesh-eaters are dependent upon plants, for the animals upon which they feed are usually plant-eaters. Mice, rabbits, squirrels, and deer are for the most part *herbivorous*, or plant-eating forms. These species are in turn killed and utilized as food by such *carnivorous*, or *predatory* forms as wolves, foxes, wildcats, weasels, hawks, and owls. In the water the same thing is true as on the land. Small aquatic animals feed upon the minute plants, and these in turn are eaten by larger aquatic animals. The waters, like the land, would soon become barren of life if plants ceased to exist.

VII. The Plant-Animal Community

Plants and animals live together in communities much as men do. We often describe the group of plants which live together as an *association*; and, of course, each plant association has living in it a number of different kinds of animals ranging from relatively simple, single-celled forms up to birds and mammals. The branch of biological science which deals with these communities of plants and animals and is concerned with all of their interrelationships is known as *ecology*. There is a great deal which we can yet learn about the ecological relationships of even the most common and familiar birds and mammals. Practical conservation of a great many species awaits a more complete knowledge along these lines.

A forest, a meadow, a marsh, or an open pond are all communities of living things. Life in any of them is rather complex. There are plants of all kinds, ranging from microscopic, single-celled ones to the larger forms of flowering plants. Although the single-celled forms usually cannot be seen with the naked eye, they are more abundant

than the more conspicuous plants; and they play an important role in the life of the community. The same may also be said of the simple, single-celled, or microscopic animals. Let us take, for example, a tract of forest land. It is much more than a mere aggregation of trees of various species, sizes, and ages. In addition to the trees there are many kinds of shrubs, woody vines, wild flowers, ferns, mosses, lichens, algae, and fungi. There are myriads of microscopic bacteria everywhere. Some of these bacteria, fungi, and even flowering plants obtain their living by directly attacking other forms of living things; and we say they are *parasitic*. There are many others which live entirely, or very largely on the dead remains of other living things; and we term them as *saprophytic*. Many bacteria and fungi cause diseases of other plants and of animals; while numerous others have an important role to play by decomposing their dead remains, thus bringing about a return to the soil of substances which can be used again by other living things. The animal life present in the forest ranges all the way from single-celled protozoans and other microscopic forms up to insects, amphibians, reptiles, birds and mammals. As we have previously pointed out, all of these animals are either directly or indirectly dependent upon the plants for their food. There is a great deal of interdependence among the living things in the forest community, or any other plant-animal community; and the various things living in a community tend to keep each other in check. You have often heard this referred to as the *balance of nature*.

Plant-animal communities are very largely influenced and even determined by such factors as temperature, amount of rainfall, and the physical nature of the soil. These communities are relatively unstable and are subject to constant changes. Thus, if there is sufficient moisture and a favorable average temperature to promote tree growth, a forest community may extend its boundaries by invading an adjacent grassland community. On the other hand a decrease in the amount of rainfall, resulting in insufficient moisture for favorable growth of trees, may permit the grassland community to extend its boundaries by an invasion of forested areas. Ponds are constantly being invaded by communities of plants extending their ranges out from the shore; and in time these water areas tend to be filled in by the growth of vegetation, forming bogs and marshes. Marshes are invaded by forests, and in the course of time they become timbered swamps. Changes in the plant life are also accompanied by changes in the animal life. During the period immediately following the retreat of the great glaciers the flora and fauna here in Pennsylvania were no doubt similar to those at present found on the Arctic tundras. In the course of time these northern forms were crowded out by other species of plants and animals moving up from the south. There is evidence that such a movement is still in progress. With the removal of the original growth of white pine and hemlock the land was largely occupied by a forest of hardwoods; and the more southern oak-hickory forest association seems to be constantly extending its range northward, replacing the more northern forest types. Under natural conditions these changes progress slowly, but man has often brought about very rapid and drastic changes through such practices as clearing the land and drainage of water areas.

When a forest is cut over and not subjected to repeated burnings,

the land soon grows up again with trees. In some cases the trees which appear will not be the same as those which originally occupied the land. The return of the *climax* or permanent type of vegetation is often gradual and marked by a series of *stages* in development. Where the original forest growth is cut and the land either put into cultivation, or subjected to repeated and thorough burning, the return of the climax type may be considerably delayed. Under these conditions it is preceded by a *succession* of plant communities all of which are temporary in nature. Often the first plants to appear will be mosses, lichens, and more or less "weedy" grasses and herbs. The second stage is marked by an invasion of shrubs and aggressive species of trees: blackberries, blueberries, sumachs, fire cherries, and the aspens. This stage, or succession, may persist for some years, and it gradually builds up the soil so that seedlings of the permanent forest trees are

When the land is subjected to repeated burning, the return to the climax or permanent vegetation may be considerably delayed.

again able to grow there. As these latter species become established and attain maturity, they crowd out the members of the preceding association. During all of these changes in the plant life there will be, of course, changes in the animals inhabiting the area. Most species of animals have definite preferences as to the kind of environment they must live in, and the changing *habitat* we have just referred to will result in corresponding changes in animal populations.

There are communities of plants and animals in the water as well as on the land. Every small pool of water, even those of a very temporary nature, is soon inhabited by plants and animals. Within but a few days a rain pool in a meadow may literally teem with living things. There will be large numbers of microscopic plants and animals: diatoms and desmids which provide food for legions of protozoans, rotifers, and crustaceans. Many of them are able to endure long periods of drying; and with the return of water they resume their activities, often completing their whole life cycle within a few hours or a few days. These tiny forms of plants and animals of course also

exist in permanent water areas as well, and their abundance there is absolutely essential to the larger forms of life. They constitute the "bread and butter" of the aquatic insects, the mollusks, and of the turtles, frogs, and fishes. In the open water, particularly close to the surface, there is a large-free-swimming community of plants and animals which are referred to as the *plankton*. For the most part these are of microscopic size. The vegetation surrounding the deeper portion of the pond appears on zones in the following order from the land: (1) A zone of aquatic or marsh shrubs such as redosier, willows, poison sumach, buttonbush, etc.; (2) A zone of wading-plants which are rooted in shallow water such as the cattails, bur reeds, pickerel weed, swamp loose-strife, etc.; (3) A zone of plants rooted to the bottom but with leaves emergent or floating on the surface such as the water-lily, spatterdock, water shield, and some of the pond-weeds; and (4) a zone of submerged aquatic plants which are rooted to the bottom or free-floating such as the waterweed (Elodea), coon-tail, water celery (Vallisneria), and certain pond-weeds. Each of these plant associations provides a suitable habitat for certain species of animals.

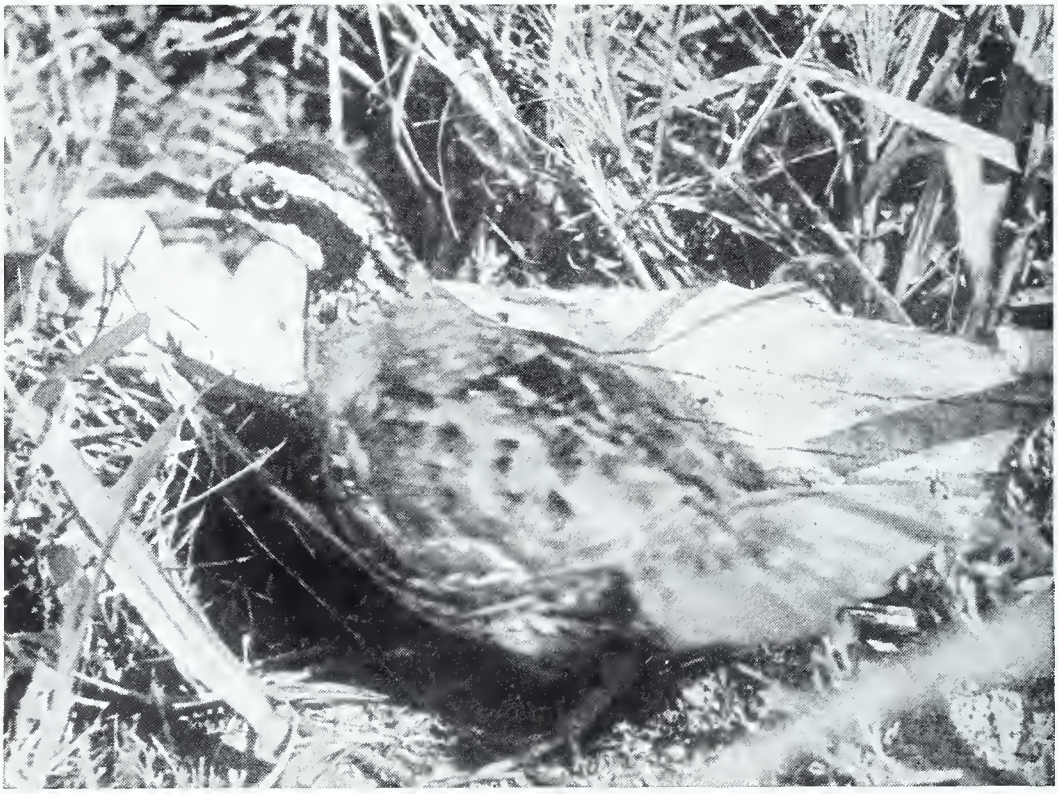
VIII. Wildlife Habitats and Their Importance

The kind of place in which an animal lives is called "habitat."

The kind of place, or type of territory, in which an animal lives is what is known as the animal's *habitat*. Each and every animal lives in a particular habitat because that environment meets its requirements for living. Animals vary widely in respect to these requirements and consequently many different habitats are chosen by the various kinds of animals. What may be ideal habitat for some species will be entirely unsuitable for many others. For instance, wide expanses of open, grassy field or meadows will satisfy all of the requirements of meadowlarks, grasshopper sparrows, and bobolinks; but they will most certainly not meet the habitat requirements of such forest and woodland species as the wood thrush, scarlet tanager, and red-eyed vireo. In respect to the choice of habitat some species are much more exacting than are others. Many birds which originally lived in the forests have adapted themselves to changes brought about by man; and they have found new habitats in groves of shade trees, in orchards, or even about his home grounds and buildings. Such birds as the robin, house wren, catbird, phoebe, barn swallow, chimney swift, and the crow have not only been able to thrive but even increase in numbers as a result of adaptation to the new environment. On the other hand there are some other species which apparently have not been able to adapt themselves to changing conditions, and they have largely disappeared with the recession of the wilderness.

Changes which take place in the environment, thus altering the habitats of wildlife, are soon reflected by changes in animal populations. A cultivated field, once abandoned, soon grows up with "weedy" plants and grasses and becomes excellent habitat for a number of birds and mammals such as moles, meadow mice, woodchucks, meadowlarks, and vesper sparrows. Within the course of a few years, if left undisturbed, this same field will be invaded by many different kinds of shrubby plants; and in due time it will become a veritable thicket of hawthorns, sumachs, blackberries, blueberries, witch hazel, and other shrubs. When it reaches this thicket stage, it will no longer be suitable habitat for many of the field species; but it will be discovered and populated by other species which prefer thickets as living quarters. It will become acceptable habitat for cottontails, quail, towhees, chats, and field sparrows. At a later period, trees such as aspens, fire cherry, birches, maples, and ashes will come in; and oaks and hickories may put in their appearance. As these trees grow, they will gradually crowd out the members of the shrub association; and we may have a fairly dense stand of saplings with little or no underbrush. This will, of course, alter the environment again and have a marked effect upon the wildlife population. Birds whose habitat is dense foliage, those which make their nests and seek their food primarily in the crowns of trees, will be the principal residents; the red-eyed vireo, redstart, scarlet tanager, and yellow-billed cuckoo being outstanding examples.

As a rule a dense, thrifty stand of nearly even-aged young trees offers little inducement to wildlife. Very few species select this type of habitat largely because of the limited amount of food which is available. It offers an inducement only to a small number of birds which feed upon insects found among the foliage of the trees themselves. As the timber stand matures and reaches the "old-age" stage, when openings appear due to the falling or toppling of occasional trees, and



The bobwhite quail thrives where man cultivates his crops provided he leaves a little cover

snags and stumps become numerous, there will be a considerably larger and more varied wildlife population. Chickadees, nuthatches, and woodpeckers, will find the decaying trunks and dead limbs ideal foraging grounds as well as perfect locations for nesting holes. Squirrels, raccoons, and wood ducks will find suitable den and nesting sites. Grouse and wild turkeys will find berry-producing shrubs in the sunny openings. Thus we have seen that with each succeeding stage in the development of the vegetation the environment changed and that some kinds of birds and mammals found suitable habitat conditions during each stage. We must not think that these stages are sharply defined; there is a gradual transition from one to another, and there is a corresponding gradual transition in the animal life as well.

The presence, or the absence, of any species of bird or animal is very largely a matter of the presence, or absence, of the right kind of habitat. Woodcock cannot live out in the middle of a dry field, and quail can't live in the middle of an extensive pine forest. House wrens may nest in a box placed in a shade tree in the back yard, but longbilled marsh wrens must have wet areas covered with marsh and a growth of swamp shrubs. Nighthawks often do nest on the pebble-covered flat roof tops of city buildings, but their close relatives the whip-poor-wills must have tracts of woodlands where they can make their nests on the ground among dead leaves and clumps of ferns. The cottontail rabbit and the bob-white quail thrive where man cultivates his crops provided he leaves a little cover, but the varying hare and the ruffed grouse must have wilder wooded areas in order

to exist. Muskrats must have marsh or other water areas with sufficient food and cover provided by cattails, sedges, and other aquatic plants. Beavers will build their dams and establish themselves along streams provided there are convenient growths of alders and aspens to furnish food and building material. It is quite evident that any animal chooses a habitat which will provide it with the desired kind of home site, an adequate supply of food, and with proper cover to serve as protection from both the elements and its natural enemies.

Any program intended to benefit wildlife must give due consideration to the importance of wildlife habitats. Very often the success or the failure of a wildlife restoration project is just a matter of how much attention is paid to the habitat requirements of the species under consideration. We cannot expect to have wildlife without having the right kind of wildlife habitat or expect to get very far along with wildlife restoration unless we first restore the wildlife habitats. Marshes must be provided for wild ducks, rails, gallinules, and muskrats. Thickets and briar patches in proximity to cultivated fields are essential for rabbits, pheasants, and quail. Growths of trees and shrubs along the streams provide better habitat for fish life by keeping the waters cooler and attracting numerous insects upon which the fish may feed. Given the proper habitat—an abundance of food and cover—and adequate protection, particularly from human influences, most species of wildlife will prosper and their numbers will increase up to the maximum number that it is possible for a given area to support.

IX. Habitats and Carrying Capacities

The first requirement in the management of any species of wildlife is that of providing sufficient and proper habitat. The exact habitat requirements must be determined in each and every case; and the land, or water, developed with these requirements in mind. If the habitat requirements of certain species cannot be provided in a given area, there is little reason to hope that such species will ever become established there; and it is best to devote one's efforts toward developing the area for species which will find suitable habitat and be able to thrive. No amount of work or wishful thinking will establish a species on land where the basic requirement—the habitat—is not suitable for the bird, or mammal, concerned. Habitats may be developed, and a great deal may be accomplished by their improvement. An abundance of the right kind of food and cover plants is necessary if any species of wildlife is to prosper.

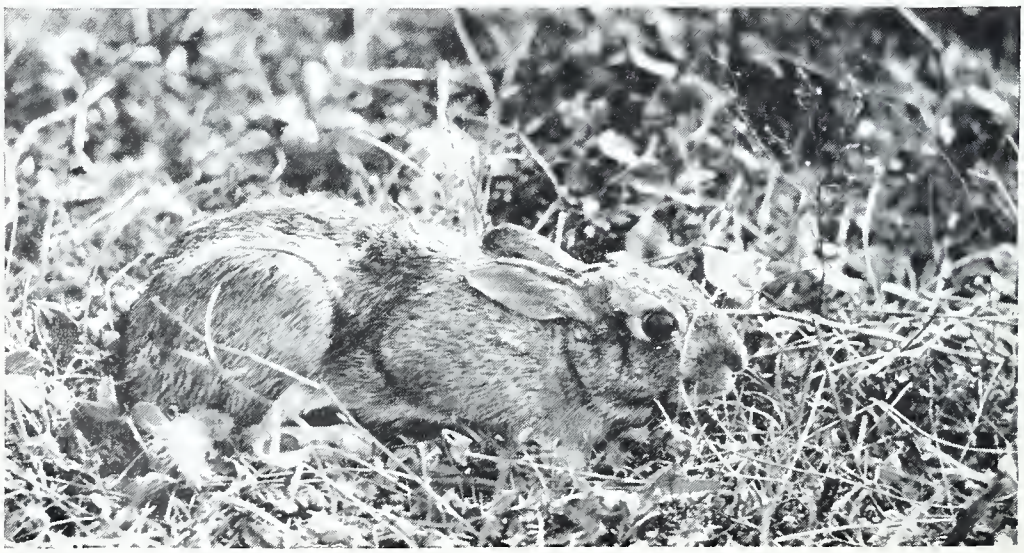
A given area, no matter how good or how poor food and cover conditions may be, will only be able to support a limited population of a given species. The size of this population is very largely regulated by the quantity of food and cover which is available. In our enthusiasm we are often prone to overlook this fact; but, nevertheless, a certain tract of land can only support so many rabbits, or quail, or deer. We are often disappointed if there are not more birds or bunnies in the "back forty"; and we are always looking around for something to blame it on, usually everything but the food and cover conditions. During the summer months the food and cover is usually quite ample and the area is able to support fairly large populations.

But wait until winter comes, and the vegetation is killed, and the trees and shrubs are shorn of their leaves. Then it is usually quite a different story. This same area during the winter months is able to provide food and sufficient cover for but a fraction of the birds and mammals which lived there quite comfortably during the summer. A certain number of them will be able to find food and cover and remain in relative security until the coming of spring. The number of individuals of a species which the area is able to support with safety through the winter months is known as the *carrying capacity* of that particular area.

We know now that it is unwise, and certainly not within the principles of good management, to permit any wildlife population to exceed the carrying capacity of the land. Nature tends to remove the surplus if it is not harvested and utilized by man. Excess populations may be driven into other adjacent areas, sometimes through strife within the species itself. Overpopulation often results in premature depletion of the food supply which will in turn result in wholesale starvation, weakening of the remaining individuals, and decimation of their numbers through disease, predation, or adverse weather conditions. In some cases the habitat may be impaired, or in extreme instances largely destroyed particularly where browsing animals such as deer are concerned.

Let us look at what has happened in the Pennsylvania deer herd. Starting with an almost negative population of these animals, and with only meager restocking, a tremendous population was built up in the course of less than thirty years. This was partially due to the effective system of protection—the abolition of indiscriminate hunting practices, the establishment of a refuge system, etc.—but their almost phenomenal comeback was largely due to extremely favorable natural factors. Thirty or forty years ago the more or less recently cut-over lands were covered with extensive thickets of sprout growth and shrubs which constituted the very best kind of deer habitat to be found anywhere. As a consequence the deer multiplied rapidly. All of the

Thickets and briar patches in close proximity to cultivated fields are essential for rabbits



"Over large areas deer lines began to appear in the forests."

time that this deer herd was increasing the new forests were growing up. As the forests grew out of the sapling stage, there was less and less browse available for more and still more deer. Then it happened; the crisis came. Over large areas deer lines began to appear in the forests. Deer began to starve. At the beginning, the carrying capacity of the land was extremely high; but in the natural course of forest development it became less and less. The deer herd, being now greatly in excess of the carrying capacity, actually ate itself out of "house and home" and often ruined the habitat of other forest species such as wild turkeys and ruffed grouse.

Pennsylvania sportsmen have always taken great pride in their deer herd. Now, whether we like it or not, the fact remains that the deer will have to be kept down to the present carrying capacity of the deer range, not what it was two, or three, or four decades ago. There can always be deer but not the plague of deer we have witnessed during the past ten years or so. It is within the interests of all concerned, including the interests of the deer themselves, that they be kept within the actual carrying capacity of the range. This has been amply demonstrated in Pennsylvania and elsewhere, and we must be sensible in the matter as far as the future is concerned.

We fail too often to recognize the importance of habitats and the significance of carrying capacities, particularly in our zeal to increase the game species. Sportsmen are prone to release more expensively pen-raised or imported stock on a piece of land than it can possibly carry with security, and then wonder what has happened to them when the open season comes around. Many of us expect every field to be full of rabbits and every thicket to be alive with birds, and we are quick to blame everything and everybody if they aren't there.

X. What About Predators?

Perhaps the most controversial subject in the whole field of wildlife conservation is that of predators and the effects of predation. Opinions regarding the subject are voluminous; but many, if not indeed most of them, are either entirely biased or founded upon far too little factual evidence. Predator-prey relationships are not at all completely understood, even by the best trained wildlife biologists.

Many theories have been advanced to explain the function of predatory species and their relation to other forms of wildlife. Most of these, however, are supported by few actual facts and very little scientific evidence. Some claim that predators play an important role in the "balance of nature"; that predators are an important factor in controlling and limiting animal populations, thus preventing a species from becoming overabundant. Another explanation is that predation is highly selective; that predators render a sort of special service to the species preyed upon by the removal of the sick, and weak, and incompetent individuals and that the virility of the flock or herd is thereby maintained at a maximum. There may be some sound reasoning behind all of these theories, but so far none of them have actually been proven scientifically.

Strictly from the biological viewpoint every living thing has its place in the world of living things. There is no good or bad among them. Each and every living thing fills its own little niche in the whole picture of life, or "web of life" as it is often called. There can be no doubt that predatory animals have a place in this natural set-up; that they perform certain definite functions and perform useful roles under strictly natural conditions which are not disturbed by man. Man, however, has vastly altered many, perhaps even most, of the original ecological relationships. He has, over large areas, greatly decimated or even wholly eliminated the original wild herds of mammals and

the huge flocks of wild fowl. He has largely replaced these wild species with his domestic herds and flocks upon which he depends for a good share of his living. From the human point of view the wild birds and mammals, and all other forms of life as well, have come to be looked upon as being either "beneficial" or "injurious" according to how they affect man's own livelihood or interests.

There are a few persons who look upon predators with purely sentimental reasoning; but the majority of us are entirely too prone, and too quick, to condemn all predators as "enemies." If a hawk or a weasel happens to kill some of the members of the barnyard flock, the average farmer is unhesitant about condemning all hawks and weasels. Similarly, the average hunter, upon witnessing any act of predation upon a game species, is quick to condemn all predatory species as "vermin." The fisherman quite often looks upon the fish-eating species as serious menaces to fish life and blames them for his inability to catch a full creel. It is often so easy for us to put the blame on predators that we overlook the really vital factors which contribute to so much of the poor hunting and the poor fishing. During recent years many scientific investigations have been made in order to determine those factors which are largely responsible for local failures of various game species. In not a single one of these was it proven that predators were a serious factor in limiting the population of the game species, but in nearly every case it was proven that the carrying capacity of the land was the primary factor.

Extensive studies made by Dr. Paul R. Errington on the bobwhite quail, both in Iowa and in Wisconsin, have proven that winter survival of these birds very largely depends upon the presence of an adequate supply of natural food and cover. It is only when the quail enter a winter season with a population much above that which the land can safely carry that losses from predation are heavy. Furthermore, these studies have revealed the fact that this surplus population would be removed by other natural factors, such as disease, if it were not removed by predators. Many other scientific investigations, based upon studies of other species, have resulted in practically the same conclusions. If any population is safely within the carrying capacity of its range, predators will have very little effect upon the security of its members. If, on the other hand, a population is much greater than the carrying capacity of its range, the excess will be rendered vulnerable to a number of natural factors which will tend to remove them. Predators are but one of these factors. From all of the facts at hand, it is evident that the time and money so often spent on ineffectual "vermin control" campaigns would be of infinitely more benefit to any species of wildlife if it were spent on efforts to improve food and cover conditions for that species.

Under certain conditions some control may have to be exercised over predators. It certainly would be difficult to convince the farmer who has been steadily losing his chickens to some species of predatory animal that he shouldn't take stern steps to stop the depredations. That isn't the same as saying that all kinds of predators should be killed indiscriminately. We have been doing that for some time. In spite of the fact that we have known for a long time that most of our hawks and owls are beneficial as far as their food habits are concerned,

we continue to persecute these birds without hesitation. We haven't, that is the most of us haven't, taken the time or put forth the effort to learn one hawk from another, to learn friend from foe. Local conditions do, of course, occasionally arise when some control measures are necessary; but we must not assume that such conditions are general or that they are justification for the widespread persecution of predatory species.

As far as predatory species are concerned there can be very little doubt but that man's economic considerations will always be paramount. There are, of course, other values, much less tangible, which must also be given some consideration. There are folks who enjoy seeing a hawk circling high in the air just as much as the sportsman enjoys that sudden, explosive whir of wings as a covey of quail takes wing. There are those among us who enjoy the beauty of the egret as much as the fisherman enjoys catching a big bass. More and more, we are coming to attach esthetic, educational, and inspirational values to wildlife. That should go a long way toward thwarting some of our otherwise destructive tendencies. No species of wildlife existing today, predator or otherwise, should be sacrificed as were the passenger pigeon, the heath hen, and the Carolina paroquet.

Most of our hawks are beneficial as far as their food habits are concerned.

XI. Wildlife for the Future

Two things are absolutely essential if we are going to assure secure wildlife populations: (1) the provision of sufficient and suitable wildlife habitats, and (2) the reservation of adequate breeding stocks. We have already discussed the importance of the wildlife habitat. That is the first essential in any program of wildlife management. It is, of course, necessary to maintain adequate breeding reserves to inhabit this land. No amount of habitat, no matter how excellent it may be, no number of refuges, or areas set aside to benefit wildlife will be of value unless the birds and the mammals are there to use them. Marsh areas won't produce ducks if there are no ducks to inhabit them. Adequate numbers of ducks, or grouse, or quail, or muskrats, or any other species must be left, after the hunting or trapping season, to live and to reproduce their kind. Game laws are intended to regulate the take of the various kinds of wildlife, so that these adequate breeding reserves may be assured; but such laws do not always meet the local requirements. Local conditions may often warrant lower bag limits than those which are "allowed by law." It is largely up to the individual landowners and the local sportsmen to determine just how much can be harvested without doing harm to the breeding reserves in any particular locality. In no case should the harvest exceed the annual crop of a species.

As pointed out previously, there are numerous possibilities afforded us to improve wildlife conditions in our respective localities. Improvements which are made in the wildlife habitat seldom will result in benefits to wildlife alone but will result in many other benefits such as the control of soil erosion, the provision of water for crops and livestock, and the creation of additional recreation areas. Very often the landowner will be able to derive additional sources of income from these wildlife lands. In this respect we might mention such possibilities as the sale of props, poles, and Christmas trees from judicious thinning operations; the leasing of hunting or of trapping rights. As a rule, if lands are properly managed for wildlife, they can be made to pay their own way. At the present time there are many, many acres which are a first class liability to their owners because they are not producing anything of any value whatsoever.

On almost any farm there are some idle acres which could be profitably developed for wildlife. Lands which are too poor, too wet, or too steep for cultivation are well adapted for just such a purpose. Lands which are badly eroding certainly need prompt attention; and erosion can be controlled by the restoration of a more or less permanent cover of vegetation such as trees, shrubs, and grass. This, of course, will benefit wildlife through an increase in the amount of food and cover such plantings afford. Farmers should be encouraged to leave a little brush here and there, particularly along roadsides and fence rows. Banks of streams should be left with permanent woody cover, or planted with trees and shrubs, to aid in controlling the erosion. The planting of nut-bearing trees and of berry-producing shrubs is highly recommended. All of these practices will result in the improvement of the wildlife habitat with direct benefit to song and insectivorous birds as well as the game species.

Water areas are always an asset if they are properly managed. The creation of small ponds, often in connection with the control of soil erosion, is becoming commonplace. These ponds may serve a multitude of uses aside from being storage places for water; they afford watering places for domestic stock, as areas for fish production, provide desirable recreational sites, etc. There are many wet spots and small marsh areas which could be developed for wildlife. Even small areas, an acre or two in extent, if properly managed are worth while as they provide excellent habitat for such marsh-dwelling birds as the rails, gallinules, and certain species of ducks. Many marsh areas yield an annual fur crop that favorably compares with crop yields on equivalent acreages of cultivated lands. We no longer need to consider marsh areas as waste land. They have tremendous possibilities and can be made to more than pay their own way.

Wooded areas are likewise a valuable asset. Dense woods, particularly those of pure stands, are of relatively little wildlife value. Woodlands in which there are numerous openings are better from the wildlife standpoint. Where areas are being replanted with trees, due consideration should be given to wildlife needs. Extensive areas planted to evergreens, such as pines and spruces, will in time have practically no value to wildlife. Mixed plantings of various hardwood species and conifers are much to be preferred. Where extensive plantings are to be made, it would be well to leave small, scattered unplanted areas and to encourage the growth of berry- and nut-producing shrubs in such areas as an incentive to wildlife. Timber stands can often be improved for wildlife by selective cuttings or thinnings, but species of trees which are valuable as wildlife food producers should not be eliminated. The culling out of all trees with natural cavities is to be discouraged. Den trees should always be spared.

Any serious attempt to manage lands and improve environmental conditions for wildlife is necessarily lounded upon a sound knowledge of the underlying biological principles. There is still a great deal that is unknown regarding the various wildlife species and their ecology. This is true not only of some rare and seldom encountered species but also of many of the commoner game and fur-bearing mammals and game birds. The more knowledge we have of the individual needs of a species the more complete will our success be in the management of that species: be it bird, or mammal, or fish. We are constantly making progress in this knowledge through our wildlife research, and in the future we should have a much better basis for the management of the various species. In any program of this sort cooperation is required of all interested individuals; and this includes the farmer, forester, soil conservationist, hunter, trapper, angler, and naturalists, both professional and amateur. If we are ever to achieve a genuine solution to our conservation problems, all must work together.